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NOTE

Lectotypication, morpho-anatomical traits and initial chemical analysis of *Psychotria condorensis* Pierre ex Pitard (Rubiaceae, *Psychotria*): A study on an endemic species from Con Dao National Park, Ba Ria-Vung Tau Province, Vietnam

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ABSTRACT: *Psychotria condorensis* Pierre ex Pitard is an endemic species described from Con Dao National Park, Ba Ria-Vung Tau province, Vietnam. This study provides the lectotype of this species and describes its micromorphological along with phytochemical characteristics. These results are used as a monograph in the identification and standardization of medicinal materials, conservation assessment of this species, and contributes information for advancing further research on conservation and its biological activities.

KEY WORDS: Anatomy, morphology, plant diversity, plant taxonomy, lectotype.

INTRODUCTION

The genus *Psychotria* Linné is one of the largest angiosperm genera in the world, estimated to include about 2000 species globally (Dwyer, 1980; Davis, 2001; Taylor *et al*., 2007). *Psychotria* species are extensively distributed in tropical and subtropical regions, including Africa and Madagascar. They exhibit well-described morphological characteristics such as being shrub, small tree, or climber, with opposite leaves, entire or bilobed stipules that are deciduous, and inflorescences in the form of cymes, racemes, or thyrses, featuring sessile or pedicellate entomophilous or distylous flowers. Their fruits are shiny with two plano-convex pyrenes, and seeds can possess ruminate or abundant albumin (Hamilton 1989, Nepokroeff *et al.*, 1999, Andersson, 2002, Chen and Taylor, 2011).

Pharmacological studies have shown that the *Psychotria* genus has a variety of biological activities, including antimicrobial, antiviral, analgesic, hypoglycemic, and strong-cancer cell-killing effects (Benevides *et al.*, 2005; Pimenta, *et al.*, 2011; Tran *et al.*, 2024). The chemical composition studies have shown that the *Psychotria* genus contains group of compounds such as alkaloid (*Psychotria malayana* Jack, *Psychotria suterella* Müll. Arg. etc.), flavonoids (*Psychotria yunnanensis* Hutch.), terpenoid (*Psychotria rubra* (Lour.) Poit., *Psychotria yunnanensis* Hutch., etc.), steroids (*Psychotria hainanensis* H.L.Li, etc.), coumarin (*Psychotria stachyoides* Benth.), tannins, organic acids, amino acids, reducing sugars, polysaccharides, fats, sterols, carotenoids, phenolic compounds, and saponins (Tran, 2018).

In Vietnam, there are estimated to be 26 species within this genus, along with one variety (Pham, 2000; Tran, 2005; Nguyen *et al.*, 2023b), including 9 known species with medicinal properties to treat respiratory and epidemic-related diseases (Vo, 2012). During our botanical survey in Con Dao National Park, Ba Ria-Vung Tau Province, Vietnam, several unknown *Psychotria* specimens were collected. After carefully examining relevant taxonomical literatures (Pitard, 1924; Pham, 2000; Tran, 2005; Chen and Taylor, 2011) and comparing morphological characters in available herbaria and digital herbarium materials of *Psychotria* specimens e.g. P, K, JSTOR Global Plants, the species matchs to *Psychotria condorensis* Pierre ex Pitard (1924). This species was first described in "Flore générale de l'Indo-chine" by Pitard (1924), and it was mentioned in the Flora of Vietnam (Pham, 2000; Nguyen, 2005). However, during our field survey, we noted some distinct characteristics that were not mentioned in the original description, especially when examining specimens in various museums where the lectotype of the species has not been recorded. Furthermore, current anatomical research on this species as well as this genus is also very limited, except for common species such as *Psychotria rubra* (Lour.) Poir. (synonym of *Psychotria asiatica* L.) (Bui and Tran, 2013), *Psychotria adenophylla* Wall. (Nguyen *et al.*,2023a), e.g. Based on the aforementioned reasons, this study is conducted with the purpose of providing relative information on designing a lectotype specimen for the

species in accordance with the Shenzhen Code Art. Art. 9.3, 9.4, 9.7, 9.12 (Turland *et al.*, 2018). Additionally, we provide an amended description of this species based on our recently collected materials, a color photograph, premilinary conversation status, and some notes of this species, the morphological characteristics and microanatomy are being examined through optical microscopy, and initial investigations into the active ingredients are being conducted to reinforce taxonomic studies as well as to explore the potential medicinal properties of this genus in the future.

MATERIAL AND METHODS

Macro-morphology. The studied materials were collected from Con Dao National Park, Ba Ria – Vung Tau province, and preserved in ethanol 70°. All photographs were captured using Canon EOS 750D mounted with Canon EF–S 60 mm f/2.8 Marco USM lens. The morphological terminology is based on Beentje (2012). Specimens and literature relevant to *Psychotria* species from the Indo-chine and neighboring countries were reviewed in various herbaria using high-resolution images from Global Plants on JSTOR, available at https://plants.jstor.org/, and through the Global Biodiversity Information Facility (GBIF), accessible at https://www.gbif.org. The morphological description's nomenclature is in line with Beentje (2012). The evaluation of conversations was conducted in accordance with the criteria set forth by the International Union for Conservation of Nature (IUCN, 2012) criteria.

Micro-morphology. The materials (including young stems, mature stems, and leaves) were manually sliced into thin sections using a razor blade. The transverse sections were clarified using chloral hydrate (8%) and acidified with acetic acid (1%). These sections were then stained with Carmine (10%) in 30 minutes and Methylene Blue (1%) in 15 seconds. The excess reagents were gradually removed using distilled water on three times, following the method described by Tran (1981). The sections were placed on slides in glycerin (10%) and covered with a slip. Finally, the prepared slides were examined under a light microscope at 10X and 40X magnifications using a Nikon Eclipse E100 (Japan).

Power characteristics. According to the method of Nguyen (2007) and Nguyen (2020). Leaves were collected, washed and dried under 50°C until constant mass, then ground into a fine powder, which was then sifted using the appropriate mesh size. The leaf flour characteristics were placed on slides in water and were observed under microscope (Nikon Eclipse E100, Japan).

Preliminary phytochemical screening. The leaf powder samples were extracted using different solvents have varying degrees of polarity, and preliminary qualitative chemical analysis was conducted based on several characteristic chemical reactions Nguyen (2007), Nguyen (2020). Different phytochemical components, such as alkaloids, flavonoids, tanins, saponins, carbohydrates, coumarins, amino acids, fats, cardiac glycosides, proanthocyanidins, anthocyanosides, polyuronides were examined for their qualitative characteristics following established procedures.

RESULTS

Anatomical characteristics

Midrib leaf-anatomy. In a sectional view, the midrib exhibits a convex shape on its lower sides (Fig. 1). The upper and lower leaf epidermis consists of a single layer and is externally shielded by a thin cuticle layer (line 1). The upper epidermis cells (line 2) are slightly larger compared to those in the lower epidermis (line 10). The lower epidermis cells, arranged adjacent to one another, take on a triangular shape of varying sizes (line 10). The outermost wall undergoes thickening and is concealed by either invisible or attenuated hair in a cross-section of the midrib (line 11). The lower collenchyma comprises 7–9 layers of isodimetric cells with thickened walls (line 9). The lower parenchyma, with 13–15 layers, features circular or sub-circular cells of assorted sizes, thin walls, and a random arrangement (line 8). The central bundle adopts a V-shaped structure, encompassing downward phloem with randomly arranged dark-pink cells (line 6), while the upward phloem's xylem is constituted by large, aligned hollow cells with thickened, lignified, and blue-colored walls (line 7), and peripheral vascular bundle sheath consists of lignified cells, blue-colored walls (line 5). The upper epidermis with one layer, upper collenchyma with 5–6 layers (line 3), and upper parenchyma (line 4) with 5–6 layers are closely mirror the structure observed in the lower layers

Leaf blade-anatomy. In the leaf blade (Fig. 2A), the upper epidermis (line 1) consists of one layer with triangular cells that are large-sized, thin-walled, and externally shielded by a thin cuticle layer. The hypodermis, located beneath the upper epidermis, is composed of polygonal cells in 1–2 layers, which are large-sized and thin-walled (line 2). The mesophyll is dorsiventral and comprises one layer of compactly arranged palisade parenchyma cells (line 3) and up to ten layers of spongy parenchyma cells (line 4), which are loosely arranged with large airspaces (line 8), moreover, the starch are found in the paliside parenchyma (line 7). The lower epidermis has small, papillae cells in one layer, which are thin-walled (line 5). The surface of the lower epidermis shows sporadic non-glandular trichomes (line 9). The stomata are confined to the lower surface and are located above the level as the adjacent epidermal cells (Fig. 4B-C, line 6).

Young stem-anatomy. The transverse section of the young stem was elliptical to sub-circular in shape (Fig. 3A), covered by a single epidermal layer composed of

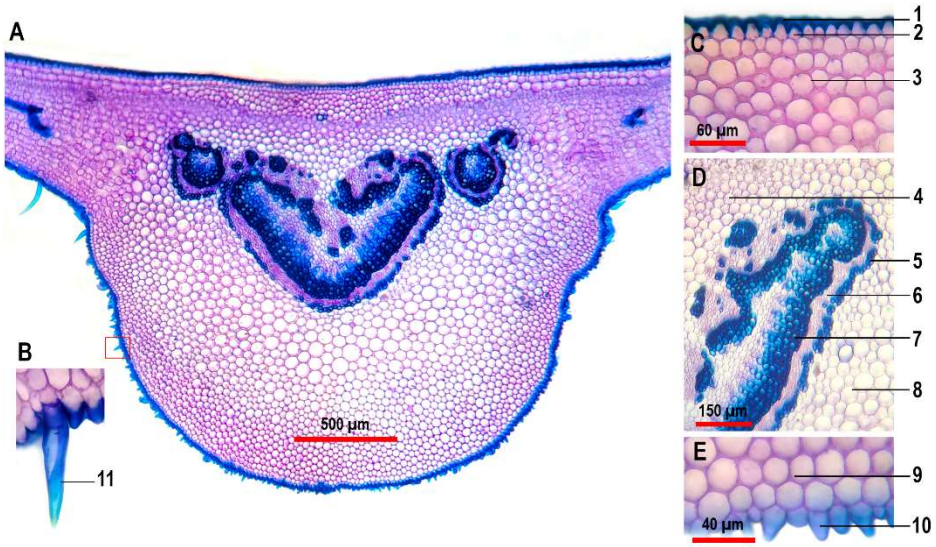

Fig. 1. Microscopic characteristics of midrib leaf cross-sections of ***P. condorensis***. **A.** Midrib cross-section. **B-E.** Enlarging the internal structures of leaf midrib. **1.** Cuticle. **2.** Upper epidermis. **3.** Upper collenchyma. **4.** Upper parenchyma. **5.** Bundle sheath. **6.** Phloem. **7.** Xylem. **8.** Lower parenchyma. **9.** Lower collenchyma. **10.** Lower epidermis. **11.** Trichomes.

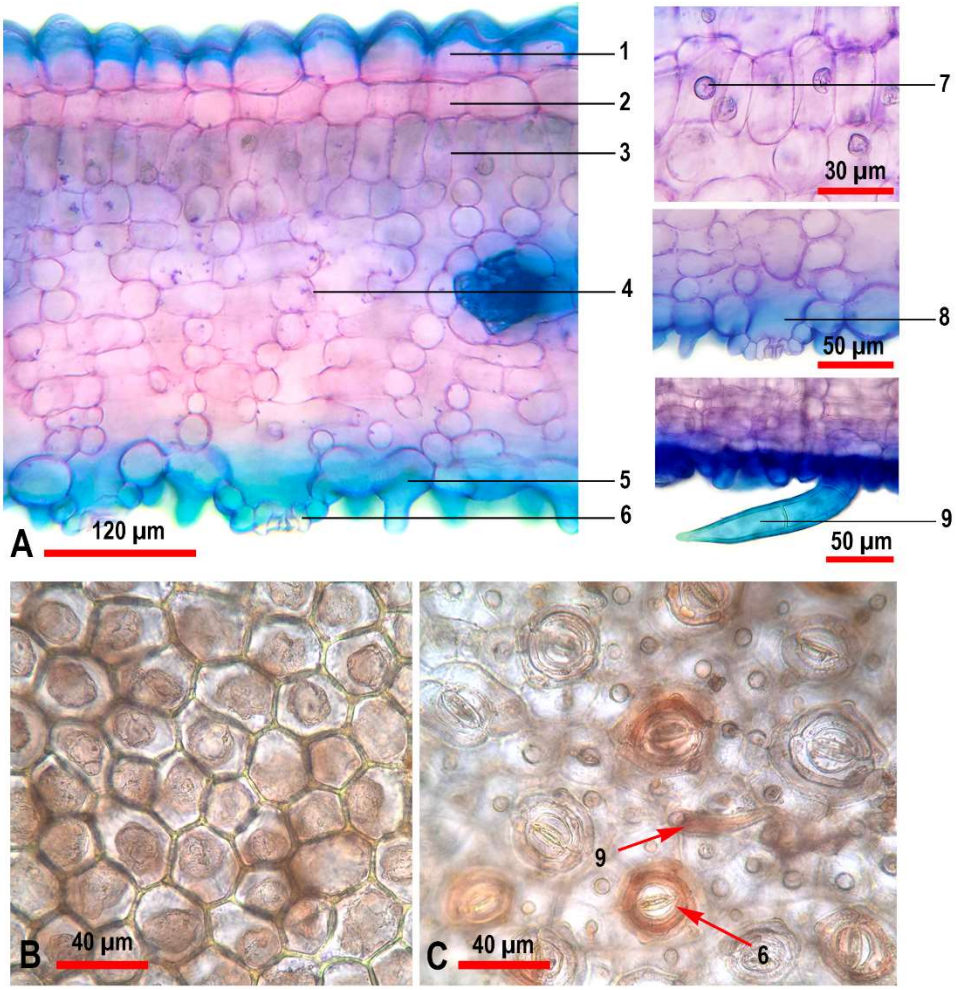

Fig. 2. Microscopic characteristics of leaf blade cross-sections of ***P. condorensis***. **A.** Blade cross-sections and enlargin the internal structures of leaf blade. **B.** The adaxial leaf surfaces. **C.** The abaxial leaf surfaces. **1.** Upper epidermis. **2.** Hypodermis. **3.** Palisade parenchyma. **4.** Spongy parenchyma. **5.** Lower epidermis. **6.** Stomata. **7.** Starch. **8.** Sub-stomatal chamber. **9.** Trichomes.

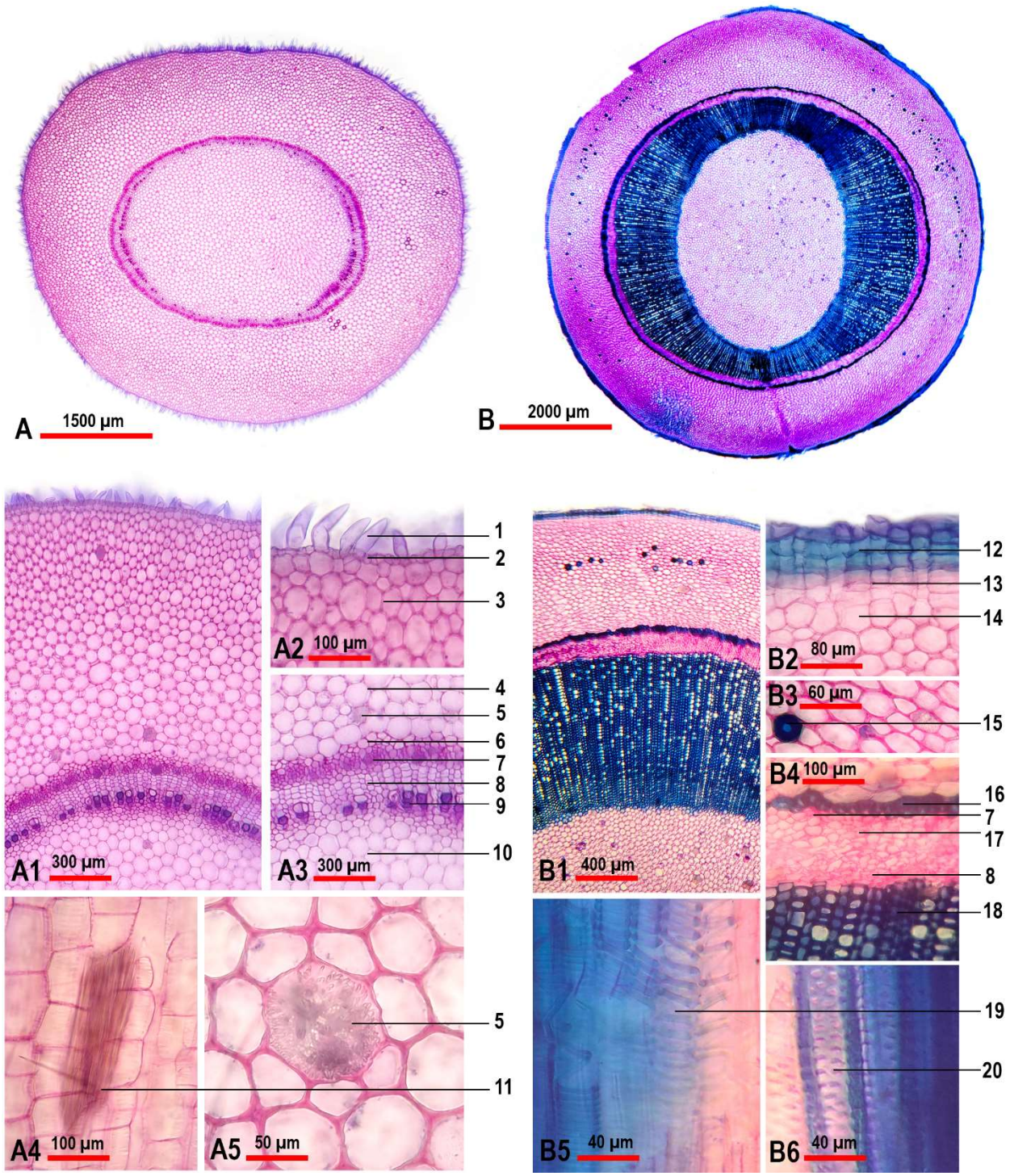

Fig. 3. Microscopic characteristics of stems cross-sections of ***P. condorensis***. **A, A1-A5.** Stem cross-sections and enlarging the internal structures of young stems. **B, B1-B6.** Stem cross-sections and enlarging the internal structures of mature stems. 1. Non-glandular trichomes. 2. Epidermic. 3. Collenchyma. 4. Parenchyma. 5. Needle-shaped crystals cross-section. 6. Sclerenchyma. 7. Primary phloem. 8. Vascular bundle. 9. primary xylem. 10. Pith parenchyma. 11. Needle-shaped crystals longitudidual-section. 12. Phellem. 13. Cork cambium bundle. 14. Phelloderm. 15. Fibers. 16. Sclerenchyma cells have thick walls that undergo lignification to form fibers. 17. Secondary phloem. 18. Secondary xylem. 19. Spiral vessel. 20. scalariform vessel.

small, adjacent, polygonal-shaped cells (Fig. 3A2, line 2) with a thick outermost wall containing non-glandular trichomes (Fig. 3A2, line 1). The collenchyma consisted of adjacent, polygonal-shaped cells in 10-12 layers, with thickened walls at the corners (Fig. 3A1-A2, line 3). Following the collenchyma, the cortical parenchyma composed multiple layers with randomly organized circle-shaped cells of varying sizes and thin walls (Fig. 3A1, line 4). The sclerenchyma included small, polygonal-shaped cells in a single layer, covering and distinguishing between the cortical parenchyma and the vascular bundle (Fig. 3A3, line 6). The vascular bundle comprised primary phloem and primary xylem arranged in an annular pattern. The externally located primary phloem contained randomly arranged polygonal cells, smaller in size and darker in color than parenchyma cells (Fig. 3A3, line 7). Internally, the primary xylem included vessels arranged radially (Fig. 3A3, line 9). The vascular cambium, situated between the primary phloem and primary xylem, consisted of rectangular cells in four layers, thin-walled, smaller in size, and arranged longitudinally (Fig. 3A3, line 8). The pith parenchyma was composed of sub-circular cells that were thin-walled, large, and arranged randomly (Fig. 3A3, line 10). In addition, the needle-shaped crystals were found scattered in parenchyma, collenchyma of young stem (Fig. 3A4-A5, line 5&11).

Mature stem-anatomy. In conjunction with the growth of cork cambium and vascular cambium, the stem developed in terms of shape and size. The structure of the transverse section of the mature stem (Fig. 3B) is similar to that of the young stem but is distinguished by the presence of periderm (Fig. 3B2), fiber sclerenchyma, and a second vascular bundle (Fig. 3B1). The cork cambium (Fig. 3B2, line 13) actively produces phellem (Fig. 3B2, line 12) on the outer side and phelloderm on the inner side (Fig. 3B2, line 14). The phellem consists of rectangular cells in two layers, adjacent and arranged to absorb a blue color; phelloderm is created beneath the cork cambium, including rectangular cells in a single layer with a thin wall and a lighter color than collenchyma and parenchyma. The sclerenchyma cells have thick walls that undergo lignification to form fibers, covering the vascular bundle (Fig. 3B4, line 16). The function of the vascular bundle (Fig. 3B3, line 8) produces secondary phloem (Fig. 3B3, line 17) and secondary xylem (Fig. 3B3, line 18). The secondary phloem externally, composed of polygonal cells with thin, wrinkled walls. The secondary xylem inward consists of large xylem vessels (spiral vessels and scalariform vessels) randomly arranged in a radial pattern. Distinguishing between the primary phloem (Fig. 3B4, line 7) and primary xylem is challenging because they are flattened by the secondary bundle. Furthermore, fibers are found in the cortical parenchyma of the mature stem (Fig. 3B3, line 15). In the longitudinal section of the secondary xylem has two types, including spiral vessel (Fig. 3B5, line 19) and scalariform vessel (Fig. 3B6, line 20).

Leaf powder. The brownish powdered leaf, having a gentle fragrance, had several microscopic characteristics, including unicellular and multicellular non-glandular trichomes (Fig. 4H & 4I). Fragments of the upper epidermis (Fig. 4A) and lower epidermis containing small stomata with two smaller guard cells were found under the microscope (Fig. 4B). Spiral (Fig. 4F) and scalariform vessel pieces (Fig. 4G) were found in the powdered material. Fragmented collenchyma (Fig. 4C), parenchyma (Fig. 4D), fiber (Fig. 4E) rarely appeared, and the circular starch granules were approximately 10-20 µm in diameter (Fig. 4K). The needle-shaped crystals were scattered or gathered in clusters that were approximately 150-200 µm long (Fig. 4J).

Preliminary analysis of the chemical composition of *Psychotria condorensis* Pierre ex Pitard leaf powder

The result of preliminary phytochemical analysis of leaf extract of *Psychotria condorensis*, including it shows the presence of flavonoids, tannins, saponins, carbohydrates, coumarins, amino acids, and negative test for alkaloids, fats, cardiac glycosides, proanthocyanidins, anthocyanosides, polyuronides (Table 1).

Table 1. Phytochemical screening of ***Psychotria condorensis*** leaves.

Chemical constituents	The test	Result	Conclusion
Alkaloids	Wagner's test	(–)	Absent
	Dragendroff' test	(–)	
Flavonoids	Cyanidin test	(+)	Present
	$FeCl_3$ 5% test	(+)	
Tannins	$FeCl_3$ 5% test	(+)	Present
	Gelatin 1% test	(–)	
	Lead acetate 10% test	(+)	
Fats	Stain test	(–)	Absent
Saponins	Foam test	(+)	Present
Carbohydrates	Fehling's test	(+)	Present
Cardiac glycosides	Keller – Kiliani's test	(–)	Absent
Coumarins	Flourescences test	(+)	Present
Amino acids	Na_2CO_3 test	(+)	Present
Proanthocyanidins	HCl 10% test	(–)	Absent
Anthocyanosides	HCl 10% + NaOH 10% test	(–)	Absent
Polyuronides	Ethanol 95° test	(–)	Absent

TAXONOMIC TREATMENT

Psychotria condorensis Pierre ex Pitard, Fl. Indo-Chine 3: 351 (1924); Pham, H.H. *P. condorensis*, An Ill. Fl. of Viet. III: 195 (2000); Tran, N.N. *P. condorensis,* in Nguyen, T.B. eds., Checkl. Pl. Spec. Vietn. 3: 141 (2005).

***Type*: VIETNAM**. Ba Ria-Vung Tau Province, Con Dao National Park, *Cochinchiaad uisulam Condor.* Sep. 1876, *Dr. Harmand No. 1932* (lectotype P [P04020420 –

Fig. 4. Microscopic features of leaf powder. **A.** piece of upper epidermis. **B.** piece of lower epidermis. **C.** Fragment of collenchyma. **D.** fragment of parenchyma. **E.** Fiber. **F.** Fragment of sriral vessels. **G.** Fragment of scalariform vessel. **H.** unicellular non-glandular trichomes. **I.** multicellular non-glandular trichomes.

http://coldb.mnhn.fr/catalognumber/mnhn/p/p04020420], **Fig. S1**; isolectotype: P04020421; K000777254 - https://data.kew.org/records/occurrences/1a2e55f9-6880-4784-9f7c-477fac50c353), **designated here**).

Description. **Shrubs**, 1–3.5 m tall. **Twigs** puberulent when young, glabrous when mature, reddish brown to gray in *vivo*, dark brown *in sicco*, stems sub-cylindrical to cylindrical, internodes 1.0–5.2 cm long. **Stipules** ovate–triangular, 5–6 mm long, green to yellowish-green when young, dark brown when dry, glabrous on both sides, apex acute to obtuse, base large oval, margin entire, caducous. **Leaves** simple, opposite-decussate, petiolate; lamina elliptic-oblong, lanceolate-oblong to obovate, 10.5–28.5 × 5.5–9.5 cm, upper surface green and lower surface light green *in vivo*, turning blackish-brown when dried, glabrous on adaxial surfaces, glabrous to very sparsely hairs on abaxial surfaces, base cuneate, apex acuminate to acute, margin entire, venation mixed brochidodromous, midrib prominent on abaxial surface, glabrous to puberulent; secondary veins 15–20 pairs, without domatia; petioles 1.0–2.2 cm long, glabrous to puberulent. **Inflorescence** terminal in new branches, cyme, erect paniculate; peduncle 2–5 cm long, puberulent, 3-4 times dichotomous, primary branches 1.2–2.1 cm long, puberulent, secondary branches 5–10 mm long, puberulent, green to dark green *in vivo*; bracts short ovate-triangular, puberulent on outer surface, glabrous on inner surface, apex obtuse, caducous. **Flowers** pedicellate; pedicel 1–3.5 mm long, glabrous to puberulent, bracteoles short-ovate, short, caducous, 1.4–1.8 mm long, puberulent on outer surface, glabrous on inner surface, apex obtuse, margin entire, caducous. **Calyx** white, cupuliform, glabrous, tube 1.4–1.9 mm long, lobes null, truncated at the top, on board barely sinuous. **Corolla** white, tube 6–8 mm long, glabrous; lobes 5–6 merous, ovate-triangular, apex acute, 3–4.5 mm long, thick and recurved at the apex, puberulent in tip outer surface, glabrous on inner surface; densely villous from throat to middle tube inside. **Stamens** 5–6, inserted, filaments very short, glabrous, erect; anthers oblong-elliptic, 1.5–1.8 mm long, apex obtuse, dorsifixed. **Ovary** 2-locular, ovule 1 in each locule; style 7–8 mm long, glabrous to puberulent; stigma 2-lobed, ca. 1 mm long. **Fruits** fleshy, globoid to ovoid, 8–11 mm long, 6–8 mm in diam., green when young, orange when ripe, glabrous, apex with persistent calyx lobes; pyrene 2, plan ventral, convex dorsal. **Seeds** semi-ellipsoid to semi-ovoid, 3–5 mm long, 3–5 mm wide, blackish brown when dry, albumin ruminate (Fig. 5).

Distribution and habitat. *Psychotria condorensis* was so far only found from its type locality, in tropical

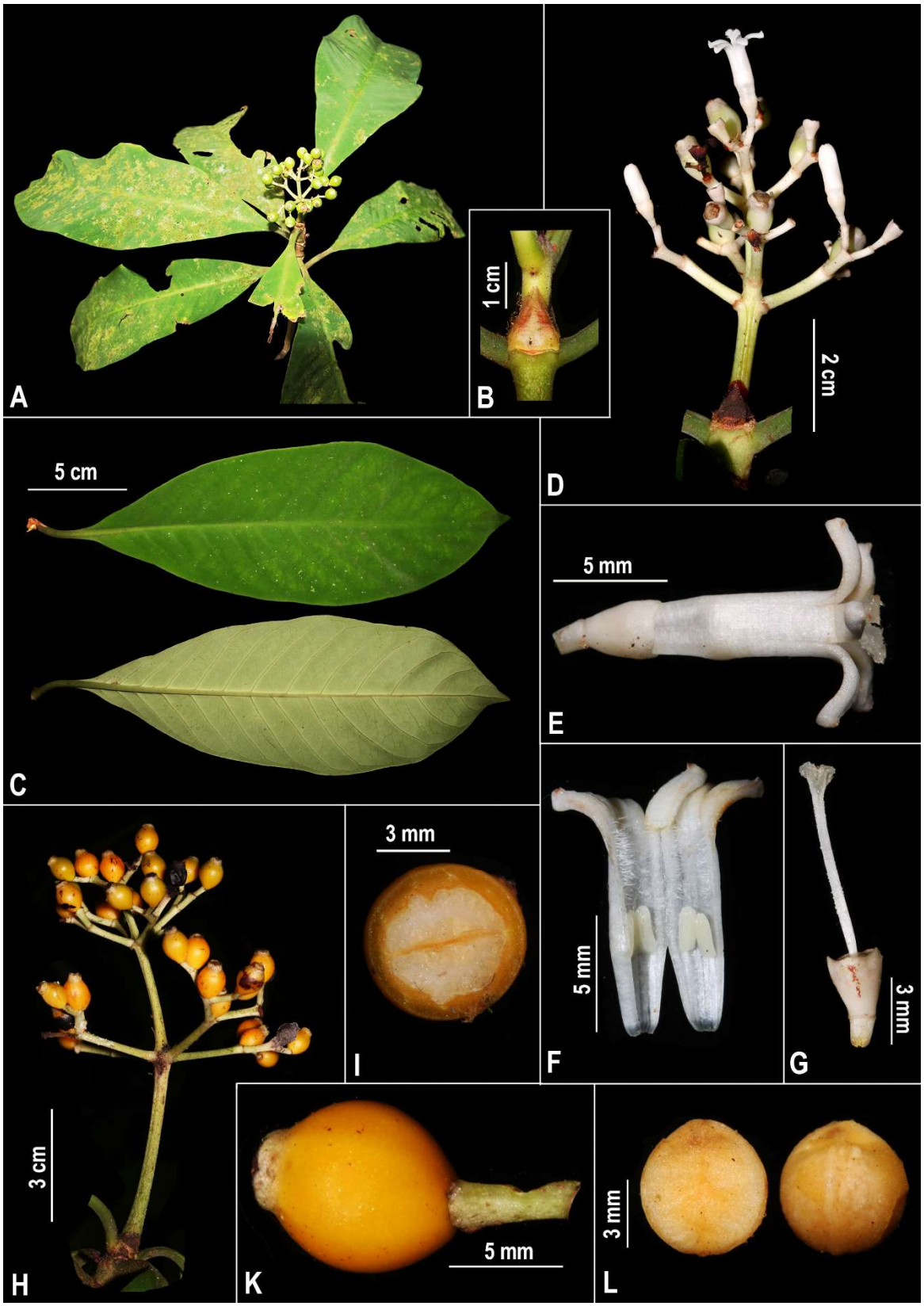

Fig 5. ***Psychotria condorensis*** Pierre ex Pitard. **A.** Branch brings young fruitescences. **B.** Stipule. **C.** Leaves (Adaxial surface and abaxial surface). **D.** Inflorescence. **E.** Flower. **F.** Corolla cross-section whows stamens. **G.** Calyx, style and stigma. **H.** Fruitescence. **I.** Fruit cross-section shows 2-pyrenes. **K.** Mature fruit. **L.** Pyrenes (Photos by Nguyen Quoc Bao).

evergreen forest in Con Dao National Park, Ba Ria – Vung Tau province, at elevation 250 m to 550 m a.l.s.

Phenology. Flowering and fruiting from January to May.

Vernacular name. Lấu Côn sơn.

Preliminary conservation status. *Psychotria condorensis* is the endemic species in Con Dao National Park, Vietnam. From our field observations, the estimated number of mature individuals is approximately under 50. The species has an extent of occurrence (EOO) of less than 1 km^2 and an area of occupancy (AOO) of less than 8 km^2. The habitat of *P. condorensis* is within the protected area of the Nation Park, which is well preserved and stable. According to the IUCN Red List criteria D, its status is Critically Endangered (CR) (IUCN, 2019).

Specimen examined. VIETNAM, Ba Ria-Vung Tau province, Con Dao National Park, elevation 255 m, March 2022, *T. B. Quyen et al., Dang 509* (VNM00070357); Ba Ria-Vung Tau province, Con Dao National Park, Mt. Thanh Gia, elevation 555 m, March 2024, *N. Q. Bao., QB 115* (VNM00070358); VIETNAM, Ba Ria-Vung Tau province, Con Dao National Park, "*Expédition du Dr Harmand en Indo-Chine 1875-77, Iles de Poulo-Condor (Cochinchine francaise)*", September 1876, *Harmand N°847 det. C.J.Pitard* (P04020418 - https://science.mnhn.fr/institution/mnhn/collection/p/item/p04020418?listCount=4&listIndex=1, P04020419- http://coldb.mnhn.fr/catalognumber/mnhn/p/p04020419).

Taxonomic notes. This entity was originally named as *Grumilea condorensis (unpublished mss.)* by J.P.L. Pierre. Subsequently, Pitard (1924) gave it a formal name based on Harmand's specimens from Condor (a group of island in Southern Vietnam which is now called Con Dao in Vietnamese) as *Psychotria condorensis* and described it in in Flore Générale de l'Indo-chine, clearly stating the specimen, '*COCHINCHINE: Condor (Harmand)*'. This voucher corresponds with two specimens from the collections of L. Pierre at the Muséum national d'Histoire naturelle (P), *viz.*, Cochinchina, island of Condor, September 1876, *Dr. Harmand No. 1932* (*P04020420*, and *P04020421*). Among them, two sheets *P04020420* and *P04020421* are represents complete specimens with hand written latin description, while *P04020420* also contains a small line drawing of pyrenes i.e. seeds (see fig. 1). The label on *P04020420*, can be read as: "*N°. 1932 Grumilea condorensis Pierre; Psychotria auct.; Flores 5–6 meri; Costulae 16–20 utrinque. Drupa lalobis vel ecostata. Pyrena plano convexus dorso praeter basin compell ovata obtuse carinata, finata, ad ventrem plana. Semen plano convexum, albumine valde commixtum; Hab Cochinchina ad insulam Condor; Stylus 8 ½ mm longa, lobis stigmatibus breviter 1 ½ cm lectus barbatis vel glabris; Coll. Dr. Harmand; 9/1876*". On the sheet *P04020421*, similar handwritten description is also present. On the opposite side, the label "HERB. L. PIERRE" following text is written: "*N°. 1932 Grumilea condorensis Pierre; Psychotria kleusa (?) Hook.f. ≠ Pierre; Uragoga seusa H.Br (?); Hab. Crescitui um. Condor.; 9/1876; Coll. Dr Harmand*". There are third and fourth specimen *(P04020418, P04020419)* with similar label, however, it mentions *Psychotria 847* and there is no mentioned of number 1932, neither does it contain and latin annotations. We can't confirm that this is a part of the same collection No. 1932, hence, we treat it as a distinct collection which was also studied by Pitard (1924) while he was describing this species.

At Kew Herbarium (K), there is a fifth specimen *K000777254* which also originates from "*HERB. L. PIERRE*" and contains further information as: "*N°. 1932 Grumilea condorensis Pierre; Psychotria condorensis Pierre; Hab. Crescitui um. Condor.; 9/1876; Coll. Dr Harmand*". Given this situation, based on Art. 9.3, 9.4, 9.12 of the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) (Turland *et al.* 2018), we have chosen the sheet from Harmand's collection in the P herbarium [P04020420] as the lectotype, as it represents a complete specimen, long latin description and line drawing of the seed. While rest of the specimens belonging to the collection *No. 1932*, viz. *P04020421* and *K000777254* are treated as Isolectotype. *Psychotria 847* (*P04020418*) is treated as lectoparatype, and *P04020419* as Isolectoparatype as per Art. 9.7 of the Shenzhen Code (Turland *et al.* 2018).

DISCUSSIONS

Psychotria condorensis is one of the species with a narrow distribution, only found outside of Con Dao, Vietnam, at altitudes ranging from 250 to 550 meters. With a low number of mature individuals, it is considered endemic and in need of conservation in this area. Morphologically, it aligns with Pitard's initial description, but this study provides additional anatomical details such as: young twigs puberulent, mature twigs glabrous, abaxial leaves blade sparsely hairs, petioles glabrous to puberulent, cyme inflorescences, white flowers long-styles morphs with long corolla tube, style glabrous to puberulent, smooth characteristic orange ripe fruits.

The anatomical characteristics of *Psychotria condorensis* adhere to classical dicotyledonous anatomy, showcasing dorsiventral leaf organization, a lignified stem exhibiting the conventional sequence of periderm, secondary phloem, vascular cambium, secondary xylem replete with vessel elements, and a central pith within the stem. The anatomical features of the leaf blade were initially described, with an average thickness of approximately 400–450 micrometers. The leaf anatomy of this species is typical of a shrub, often found growing under the canopy of forests. The paliside layer includes one player, while the spongy layer is thicker and with prominiment air spaces. In this study, the larger upper epidermic covered with cuticul which are reported present on the adaxial surface of *P. leiocarpa*, *P. glaziovii, P. hoffmannseggiana* (Moraes *et al*., 2011). The existence or lack of cuticular ornamentation has previously been documented in *Psychotria* species that reside in moist, shaded areas. (Quinteiro *et al*., 2006). The hypodermis

under the upper epidermic, this observation was first documented, the hypodermis is one of the characteristic structures in the species, serving a storage function. According to previous anatomical reports, the hypodermis absent in other species, such as: *P. fractistipula* L.B.Sm., R.M.Klein & Delprete (de Oliveira *et al*., 2020), *P. deflexa* DC., *P. leiocarpa* Cham. &, *P. racemosa* Rich. (Moraes *et al*., 2011), *P. adenoplylla* Wall. (Nguyen *et al*., 2023a). This detail is also considered important in the classification of this genus. Particularly, the morphology of the lower epidermal cells of the leaves in this species differs significantly from those studied previously, its distinguished by having papillae cells and thin-walled. In addition, the paracytic stomata, which are common in the Rubiaceae family (Metcalfe and Chalk, 1950), only find in the lower epidermic of this species. Moreover, the trichomes are present in the abaxial suface of leaves, which are present *in P. hoffmannseggiana*, *P. carthagenensis*, *P. deflexa* and *P. vellosiana*.

The anatomical characteristics of the stems of *Psychotria condorensis*, first documented here, exhibit similarities with studies of other *Psychotria* species, including the shape of the main vein bundle, the presence of crystalloid and starch bundles within the stem, as well as the type of wood pith within the main vein bundle of the stem. Additionally, the primary structure of the stem, a previously undescribed feature in the original literature, is described for the first time, revealing numerous single or multicellular hairs formed by elongated epidermal cells, although outward appearance makes them difficult to discern. The characteristics of the secondary stem indicate a wood vascular structure consistent with the research of Koek-Noorman (1977), with wood classified as type II, and analogous to the anatomical features of P. deflexam, P. vellosiana, P. leiocarpa (Marques *et al.*, 2015).

The presence of crystals in higher plants is common and linked to physical defense, oxalate removal from metabolism, calcium storage, and light regulation during photosynthesis in shade-grown plants (Franceschi and Nakata, 2005). The presence of crystals in the *Psychotria* species is important diagnostic characteristics for the genus (Moraes *et al*., 2011). Raphide bundles are prevalent in the Rubioideae subfamily, including *Psychotria*, according to Lersten (1974), who also found druses to be common in South American *Psychotria* species. In this study, the raphide bundles was found not only in the midrib, leaf blade, petioles, but also in the young and mature stems.

This is the first time that the phytochemical of *Psychotria condorensis* has been reported in the study. The majority of constituents, including flavonoids, tanins, saponins, carbohydrates, coumarins, amino acids, were scientifically proven to display potent biological importance, and have benificial impacts on treating deseases among others anti-cancer, antibacterial, antioxidant, prevent diabetes, and additional biological functions (Banno *et al.*, 2004, Venugopala *et al.*, 2013; Ramamurthy and Sathiyadevi, 2017).

To formulate conservation strategies for the species, species identification, density assessment, and research on both macro and micro morphological characteristics are crucial. Apart from providing information for classification and phylogeny construction, plant morphology and anatomy elucidate the relationship between these structures and their physiological functions. The information provided by this study will contribute to establishing a foundation for conservation, propagation, and the potential development of medicinal resources for the species in the future.

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